REMARKS

Claims 1 to 6 are pending in this application. Claim 7 and 8 have been cancelled. Claims 1 to 6 have been rejected under 35 U.S.C. § 102(b). Favorable reconsideration of the claims is requested in view of the within remarks.

1. Election/Restriction

Responsive to the Examiner's requirement, Applicant has cancelled non-elected claims 7 and 8. Applicant respectfully requests rejoinder of claim 7 and 8, if independent claim 1 is allowed.

2. Rejection of Claims as Anticipated Under 35 USC §102(b)

The Examiner has rejected Claims 1-6 under 35 USC. §102(b) as anticipated by U.S. Patent No. 5,667,758 to Matsugi ("Matsugi"). The Examiner bases this rejection on the conclusion that Matsugi incorporates a heat pipe heat transfer device (9) on the exterior wall of his reaction vessel and that Matsugi's heat exchange device can be viewed as a "heat pipe" according to the present claims because the pending claims do not recite a porous medium affixed to a heat transfer surface. The Examiner further takes the position that the definition of heat pipe in the specification at page 3 is not read into the claims.

Applicant respectfully requests reconsideration of both of the above conclusions for the below reasons.

The Examining Attorney finds that no evidence has been submitted to demonstrate that a "heat pipe heat transfer device" is restricted to the description of the specification of U.S. Patent No. 2,350,348. Accordingly, the Examining Attorney concludes that claims can be construed broadly, whereby the rejection in view of Matsugi can be maintained. Applicant respectfully submits that this rejection is unfounded because the term "heat pipe" is a widely recognized term of art which is recognized by those skilled in the art to reference heat

transfer devices which utilize the evaporation of a cooling fluid from a porous medium affixed to a heat transfer surface to absorb heat. The term "heat pipe" is widely used in the technical literature to reference such devices, as illustrated in the following web pages, copies of which are attached:

1. www.aavidthermalloy.com/products/heatpipe/index.shtml
2. www.npowertek.com/what.html
3. www.cheresources.com/htpipes.shtml

The term heat pipe is also widely used in the title, specification and claims of numerous issued U.S. patents to identify the particular type of heat transfer device referenced above without further explanation of the meaning of the term. For example, the Examiner is referred to the titles and claims in U.S. Patent Nos. 4,582,125; 6,535,381; 6,571,683 and 6,647,625.

"Heat pipe" is specifically referenced in the definition of the devices covered by U.S. Class 165/104.26 and a search of this Class and Subclass finds hundreds of patents which reference "heat pipe" in their titles. Further, a search for patents assigned to U.S. Classification 165/104.26 which reference "heat pipe" in their claims, but which do not further describe the heat pipe by referencing the words wick or porous finds 161 patents. In this connection, see the attached search results.

Accordingly, the technical literature and past practice of the U.S. Patent Office clearly establish that heat pipe is a term of art which those skilled in the art understand to reference a particularly type of heat transfer device.

Further, Applicants' claims are fully consistent with Applicants' specification which at page 3, lines 5-9 advises that heat pipes utilize evaporation of a cooling fluid from a

porous medium affixed to a heat transfer surface to absorb heat, and that in the present invention, a heat pipe system is applied to an external surface of a tank reactor.

It is respectfully submitted that under the circumstances, there is no need to reference the specification to understand the meaning of the term heat pipe and that in any event, reference to the present specification should have clearly identified the meaning of the term since no limitation from the specification must be read into the claims.

Under the circumstances, Applicants submit that the claims as originally filed were definite and limited to a well known term of art, the "heat pipe", which does not encompass heat transfer devices of the type utilized in Matsugi, for the reasons explained in the previously filed Response to Official Action. If the search performed by the Examiner would not have uncovered all relevant prior art because it misconstrued the meaning of the term heat pipe, the Final Rejection should be withdrawn and a new search performed. Since the claims as filed were definite and are patentable over the cited prior art, it would be unjust to require Applicants to file a continuation application to overcome the Final Rejection. Further, since the term of any patent issuing from this application will run from the filing date of this application, Applicants should not be subjected to unnecessary delay associated with refiling the instant application.

If the search originally performed by the Examining Attorney was sufficiently broad to uncover all relevant prior art, the presently pending claims clearly define over the prior art of record and all claims should be allowed. Further, when the pending claims are properly construed, it is evident that the sealed heat pipes covered by Claims 2-6 of the application and the thermosyphon type heat pipes covered by claims 7 and 8 of the application are two well known varieties of heat pipe encompassed by independent Claim 1. Under the circumstances, upon the allowance of Claim 1, the restriction requirement should be withdrawn and Claims 7 and 8 rejoined in the application.

For the foregoing reasons, it is submitted that the presently pending claims are allowable and early issuance of a Notice of Allowability is requested.

No fee is believed to be necessary in connection with the filing of this paper. However, the Commissioner is hereby authorized to charge any fee required with respect to this Response to Deposit Account No. 50-0540. In the event that the Examining Attorney believes that there are any remaining issues which might possibly be resolved by a telephone interview, Applicants' attorney respectfully request the same. Applicants' attorney can be reached at the number provided below.

Dated: January 7, 2004

William Spatz

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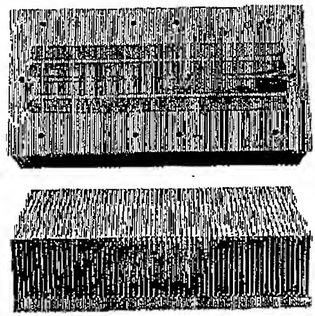
Heat Pipe Assemblies

Although heat pipes themselves do not actually dissipate significant amounts of heat, they effectively transfer heat without a large increase in temperature. This transfer capability allows for positioning large amounts of heat dissipation surface at a point remote from the heat generator. Typically heat pipes range from 6 mm (1/4") O.D. to 25 mm (1.00") O.D. and will carry 100 to 1000 watts, respectively. The length of the heat pipe, type of fluid in the pipe, return wick type, and the number of bends in the pipe relate directly to the overall temperature rise of the heat pipe system.



Design Guidelines

Orientation
In most cases, the application must have gravity working with the system; that is, the evaporator section (heated) must be lower, with respect to gravity, than the condenser (cooling) section.

Features

- Provide high thermal conductance with minimal temperature rise
- Distribute high heat loads
- Concentrate or disperse thermal power density, allowing matching of heat sources and heat sinks with differing thermal characteristics
- Separate heat source and heat sink, allowing placement of power devices in areas with insufficient space to add a heat sink capable of dissipating the amount of heat produced
- Reduce overall system size and costs

Temperature Limits
Most pipes use water and methanol/alcohol as the working fluids. Pipes will operate at temperatures as low as -40°C, but can carry only a fraction of the heat they can carry at temperatures of 0°C and higher. Upper temperature limits depend on the fluid, but 60°C to 80°C is the average limit.

Heat Removal
Heat can be removed from the condenser using air cooling in combination with either extrusion, bonded-fin heat sinks, or flat-fin stock. Enclosing the condenser in a cooling jacket allows liquid cooling.

HIContact Option
To help decrease the temperature rise between the heat generator and the heat pipe working fluid, a HIContact design can be used to make intimate contact between the mounting surface and the part to be cooled.

Limitations

- Exceeding the rated thermal power that can be dissipated at a given temperature will increase the overall temperature differential along the heat pipe.
- Exceeding the pumping capacity of the wick will

cause the temperature to rise rapidly.
- Exceeding the critical power density at any point in the input area can cause thermal runaway.

Heat Pipe Operation

A heat pipe is a closed evaporator-condenser system consisting of a sealed, hollow tube whose inside walls are lined with a capillary structure or wick. Thermodynamic working fluid, with substantial vapor pressure at the desired operating temperature, saturates the pores of the wick. When heat is applied to the heat pipe, its fluid heats and evaporates. As the evaporating fluid fills the hollow center of the wick, it diffuses throughout the heat pipe. Condensation of the vapor occurs wherever the temperature is even slightly below that of the evaporation area. As it condenses, the vapor gives up the heat it acquired during evaporation. This effective thermal conductance helps maintain constant temperatures.

Attaching a heat sink to a portion of the heat pipe makes condensation take place at this point of heat loss and establishes a vapor flow pattern. Capillary action within the wick returns the condensate to the evaporator (heat source) and completes the operating cycle. This system, proven in aerospace applications, transmits thermal energy at rates hundred of times greater and with a far superior energy-to-weight ratio than can be gained from the most efficient solid conductor.

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What is Heat Pipe?

TTIC Heat Pipe Features:

1. Provide high thermal conductivity with small temperature difference.
2. Fast thermal response.
3. Small size and light weight.
4. Large variety of shapes.
5. No electrical power supply required, and maintenance free.
6. Reduce overall system size and costs.

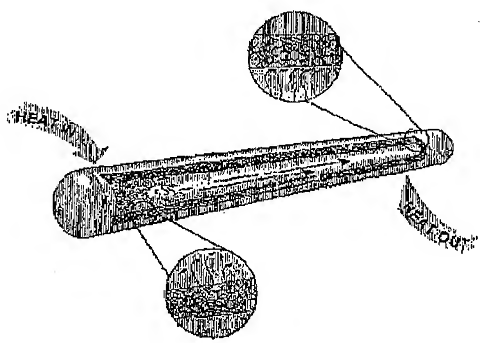
TTIC Heat Pipe

A efficient heat pipe system can be afftected by length of a heat pipe, type of fluid in a return wick type, and the number of bends in a heat pipe.

TTIC heat pipe technology has been applied to computer cooling for years. We provid cost effective heat pipe solution. Its small, compact profile and light weight allow it to m demanding requirements of computer.

Sintered Powder

This process will provide high power handling, low temperature gradients and high cap for anti-gravity applications. The photograph shows a complex sintered wick with sever channels and small arteries to increase the liquid flow rate. Very tight bends in the hea achieved with this type of structure.



What's Heat Pipe?

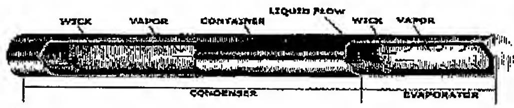
A heat pipe is a simple device that can quickly transfer heat from one point to another, usually used for cooling an electronic component in air-conditioners, refrigerators, heat

transistors, capacitors, etc. Heat pipes are also used in laptops to reduce the working t for better efficiency.

Heat Pipe Structure:

A heat pipe is consisting of following three basic components:

1. container
2. the wick or capillary.
3. the working fluid



First, the container is a sealed, hollow tube, which can isolate the working fluid from th environment and can maintain the pressure differential across its walls, and enable tra to take place from and into the working fluid. Inside walls of the container are lined with structure, which is called capillary structure or wick. The prime purpose of the wick is to capillary pressure to transport the working fluid from the condenser to the evaporator.F working fluid is contained in wick structured container. The first consideration of choosi working fluid is the operating vapour temperature range. Most pipes use water and methanol/alcohol as working fluid.

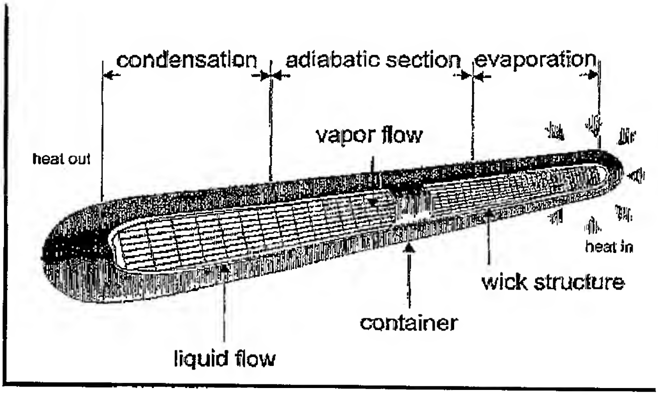
How do Heat Pipes Operate?

One end of the heat pipe attached to the heat source. As the heat rising to the desired temperature, the tube boils the working fluid and turns it into a vapor.

As the evaporating fluid fills the hollow center of the wick, it spreads throughout the he toward to the other cold end. Condensation of the vapor occurs wherever the temperat slightly below that of the evaporation area. As it condenses, the vapor gives up the he during evaporation and the condensed working fluid is then sucked back to the evapor along the wick structure. This thermodynamic cycle continues and helps maintain cons temperatures.

Attaching a heat sink to a portion of the heat pipe makes condensation take place at th heat loss and establishes a vapor flow pattern. Capillary action within the wick returns condensate to the evaporator(heat source) and completes the operating cycle.

Heat Pipe Operating Animation



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Taiwan, R.O.C.

What is a Heat Pipe?

Introduction

A heat pipe is a simple device that can quickly transfer heat from one point to ano They are often referred to as the "superconductors" of heat as they possess an extr ordinary heat transfer capacity & rate with almost no heat loss.

The idea of heat pipes was first suggested by R.S.Gaugler in 1942. However, it w until 1962, when G.M.Grover invented it, that its remarkable properties were app & serious development began.

It consists of a sealed aluminum or copper container whose inner surfaces have a wicking material. A heat pipe is similar to a thermosyphon. It differs from a therm by virtue of its ability to transport heat against gravity by an evaporation-condens cycle with the help of porous capillaries that form the wick. The wick provides th capillary driving force to return the condensate to the evaporator. The quality and wick usually determines the performance of the heat pipe, for this is the heart of t product. Different types of wicks are used depending on the application for which pipe is being used.

Design Considerations

The three basic components of a heat pipe are:

1. the container
2. the working fluid
3. the wick or capillary structure

Container

The function of the container is to isolate the working fluid from the outside envir It has to therefore be leak-proof, maintain the pressure differential across its walls enable transfer of heat to take place from and into the working fluid.

Selection of the container material depends on many factors. These are as follows

- Compatibility (both with working fluid and external environment)
- Strength to weight ratio

- Thermal conductivity
- Ease of fabrication, including welding, machineability and ductility
- Porosity
- Wettability

Most of the above are self-explanatory. A high strength to weight ratio is more im in spacecraft applications. The material should be non-porous to prevent the diffu vapor. A high thermal conductivity ensures minimum temperature drop between t source and the wick.

Working fluid

A first consideration in the identification of a suitable working fluid is the operati vapour temperature range. Within the approximate temperature band, several poss working fluids may exist, and a variety of characteristics must be examined in ord determine the most acceptable of these fluids for the application considered. The requirements are:

- compatibility with wick and wall materials
- good thermal stability
- wettability of wick and wall materials
- vapor pressure not too high or low over the operating temperature range
- high latent heat
- high thermal conductivity
- low liquid and vapor viscosities
- high surface tension
- acceptable freezing or pour point

The selection of the working fluid must also be based on thermodynamic conside which are concerned with the various limitations to heat flow occurring within th pipe like, viscous, sonic, capillary, entrainment and nucleate boiling levels.

In heat pipe design, a high value of surface tension is desirable in order to enable pipe to operate against gravity and to generate a high capillary driving force. In ac high surface tension, it is necessary for the working fluid to wet the wick and the material i.e. contact angle should be zero or very small. The vapor pressure over t operating temperature range must be sufficiently great to avoid high vapor velocit

which tend to setup large temperature gradient and cause flow instabilities.

A high latent heat of vaporization is desirable in order to transfer large amounts o: with minimum fluid flow, and hence to maintain low pressure drops within the he The thermal conductivity of the working fluid should preferably be high in order t minimize the radial temperature gradient and to reduce the possibility of nucleate at the wick or wall surface. The resistance to fluid flow will be minimized by choi fluids with low values of vapor and liquid viscosities. Tabulated below are a few r with their useful ranges of temperature.

MEDIUM	*MELTING PT. (°C)*	*BOILING PT. AT ATM. PRESSURE (°C)*	*USEFUL RANGE (°C)*
Helium	-271	-261	-271 to -269
Nitrogen	-210	-196	-203 to -160
Ammonia	-78	-33	-60 to 100
Acetone	-95	57	0 to 120
Methanol	-98	64	10 to 130
Flutec PP2	-50	76	10 to 160
Ethanol	-112	78	0 to 130
Water	0	100	30 to 200
Toluene	-95	110	50 to 200
Mercury	-39	361	250 to 650
Sodium	98	892	600 to 1200
Lithium	179	1340	1000 to 1800
Silver	960	2212	1800 to 2300

Wick or Capillary Structure

It is a porous structure made of materials like steel, alumunium, nickel or copper i ranges of pore sizes. They are fabricated using metal foams, and more particularly the latter being more frequently used. By varying the pressure on the felt during a various pore sizes can be produced. By incorporating removable metal mandrels, . arterial structure can also be molded in the felt.

Fibrous materials, like ceramics, have also been used widely. They generally have pores. The main disadvantage of ceramic fibres is that, they have little stiffness ar require a continuos support by a metal mesh. Thus while the fibre itself may be ch compatible with the working fluids, the supporting materials may cause problems recently, interest has turned to carbon fibres as a wick material. Carbon fibre filan have many fine longitudinal grooves on their surface, have high capillary pressure chemically stable. A number of heat pipes that have been successfully constructed carbon fibre wicks seem to show a greater heat transport capability.

The prime purpose of the wick is to generate capillary pressure to transport the wo fluid from the condenser to the evaporator. It must also be able to distribute the li around the evaporator section to any area where heat is likely to be received by th pipe. Often these two functions require wicks of different forms. The selection of for a heat pipe depends on many factors, several of which are closely linked to the properties of the working fluid.

The maximum capillary head generated by a wick increases with decrease in pore The wick permeability increases with increasing pore size. Another feature of the which must be optimized, is its thickness. The heat transport capability of the hea raised by increasing the wick thickness. The overall thermal resistance at the evap also depends on the conductivity of the working fluid in the wick. Other necessar properties of the wick are compatibility with the working fluid and wettability.

The most common types of wicks that are used are as follows:

Sintered Powder

This process will provide high power handling, low temperature gradients and hig capillary forces for anti-gravity applications. The photograph shows a complex sintered wick with several vapor channels and small arteries to increase the liquid flow rate. Very tight bends in the heat pipe can be achieved with this type of struc

Grooved Tube

The small capillary driving force generated by the axial grooves is adequate for lc power heat pipes when operated horizontally, or with gravity assistance. The tube readily bent. When used in conjunction with screen mesh the performance can be considerably enhanced.

Screen Mesh

This type of wick is used in the majority of the products and provides readily vari characteristics in terms of power transport and orientation sensitivity, according t number of layers and mesh counts used.

Working

Inside the container is a liquid under its own pressure, that enters the pores of the material, wetting all internal surfaces. Applying heat at any point along the surfac heat pipe causes the liquid at that point to boil and enter a vapor state. When that l the liquid picks up the latent heat of vaporization. The gas, which then has a highe pressure, moves inside the sealed container to a colder location where it condense the gas gives up the latent heat of vaporization and moves heat from the input to t end of the heat pipe.

USPTO PATENT FULL-TEXT AND IMAGE DATABASE

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Searching 1976 to present...

Results of Search in 1976 to present db for:
(((CCL/"165/104.26" AND ACLM/"heat pipe") ANDNOT ACLM/porous) ANDNOT ACLM/wick): 161 patents.
Hits 1 through 50 out of 161

Next 50 Hits

Jump To

Refine Search CCL/"165/104.26" AND ACLM/"heat pipe" ANDNOT AC

	PAT. NO.		Title
1	6,661,660	T	Integrated vapor chamber heat sink and spreader and an embedded direct heat pipe attachment
2	6,595,269	T	Flexible heat pipe structure and associated methods for dissipating heat in electronic apparatus
3	6,585,039	T	Composite overmolded heat pipe construction
4	6,571,863	T	Turbulence inducing heat pipe for improved heat transfer rates
5	6,535,386	T	Electronic assembly having a heat pipe that conducts heat from a semiconductor die
6	6,523,259	T	Method of manufacturing a heat pipe
7	6,519,149	T	Radiator mechanism and electronic apparatus
8	6,478,997	T	Polymer heat pipe with carbon core
9	6,460,612	T	Heat transfer device with a self adjusting wick and method of manufacturing same
10	6,437,983	T	Vapor chamber system for cooling mobile computing systems
11	6,382,306	T	Geometrical streamline flow guiding and heat-dissipating structure
12	6,367,263	T	Integrated circuit refrigeration device
13	6,303,191	T	Process for the production of a heat pipe
14	6,269,866	T	Cooling device with heat pipe
15	6,269,865	T	Network-type heat pipe device
16	6,262,892	T	Cooling fan for computing devices with split motor and fan blades
17	6,186,755	T	Scroll fluid machine having a heat pipe inside the drive shaft
18	6,169,660	T	Stress relieved integrated circuit cooler

19 6,167,955 T Multi-mode heat transfer using a thermal heat pipe valve
20 6,164,368 T Heat sink for portable electronic devices
21 6,152,213 T Cooling system for electronic packages
22 6,148,906 T Flat plate heat pipe cooling system for electronic equipment enclosure
23 6,070,654 T Heat pipe method for making the same and radiating structure
24 6,065,529 T Embedded heat pipe structure
25 6,047,766 T Multi-mode heat transfer using a thermal heat pipe valve
26 6,041,850 T Temperature control of electronic components
27 6,026,890 T Heat transfer device having metal band formed with longitudinal holes
28 6,003,591 T Formed laminate heat pipe
29 5,960,866 T Method for manufacturing cooling unit comprising heat pipes and cooling unit
30 5,937,936 T Heat sink for portable electronic devices
31 5,899,265 T Reflux cooler coupled with heat pipes to enhance load-sharing
32 5,841,244 T RF coil/heat pipe for solid state light driver
33 5,785,088 T Fiber pore structure incorporate with a v-shaped micro-groove for use with heat pipes
34 5,720,339 T Refractory-composite/heat-pipe-cooled leading edge and method for fabrication
35 5,682,943 T Honeycomb sandwich panel with built in heat pipes
36 5,647,429 T Coupled, flux transformer heat pipes
37 5,560,423 T Flexible heat pipe for integrated circuit cooling apparatus
38 5,522,455 T Heat pipe manifold with screen-lined insert
39 5,465,782 T High-efficiency isothermal heat pipe
40 5,465,708 T Trough-shaped collector
41 5,460,163 T Trough-shaped collector
42 5,409,055 T Heat pipe type radiation for electronic apparatus
43 5,360,058 T Heat pipe for transferring heat
44 5,358,033 T Heat pipe, with a cooled bubble trap
45 5,346,000 T Heat pipe with a bubble trap
46 5,335,720 T Heat pipe
47 5,314,011 T Heat pipe
48 5,309,986 T Heat pipe
49 5,219,021 T Large capacity re-entrant groove heat pipe
50 5,219,020 T Structure of micro-heat pipe

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